Transfer Reactions Around ^{68}Ni at REX-ISOLDE

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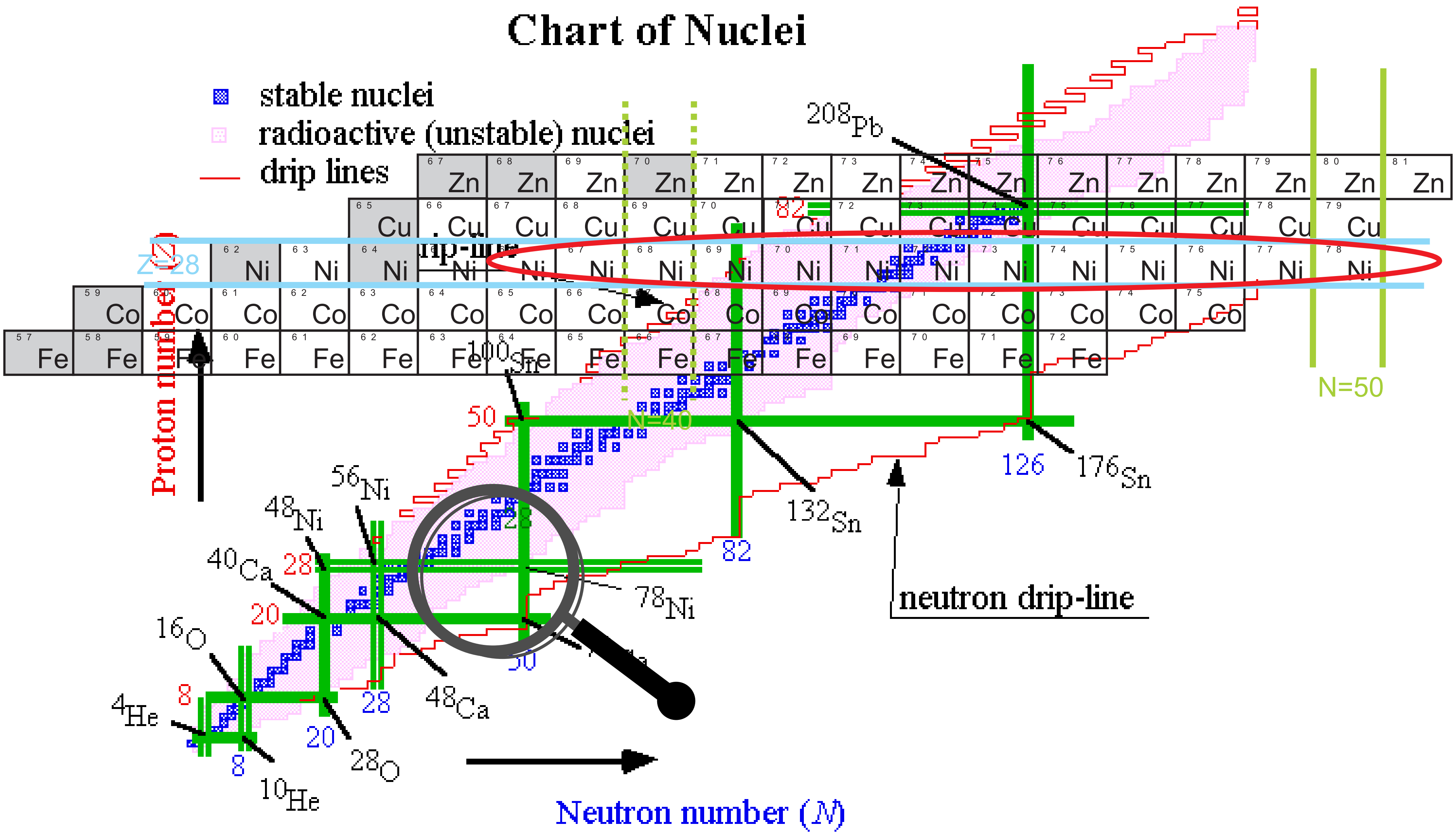
and the MINIBALL collaboration & REX-ISOLDE collaboration

1. Outline

- **Introduction**
  - Region of interest
  - Why to study the $^{66}Ni(d,p)^{67}Ni$
- **Experimental setup**
  - ^{66}Ni beam at REX-ISOLDE
  - Detectors – 4π Si barrel configuration
- **Technique**
- **Simulations**
  - Theoretical calculations
  - Results
- **Conclusions**

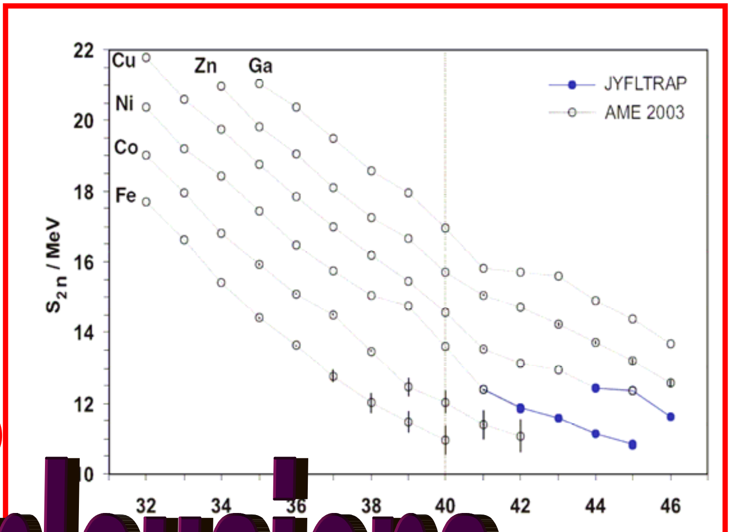
2. Introduction



2. Introduction

Is the nature of the N=40 subshell closure understood?

- First excited state 0^+ at higher energies
- The 2^+ state at larger excitation energy
- Small B(E2, $0^+ \rightarrow 2^+$)
- No irregularity at the S_{2n} or at the binding energies
- Fragile nature of the N=40 subshell closure
- Other reasons for the small observed B(E2, $0^+ \rightarrow 2^+$)



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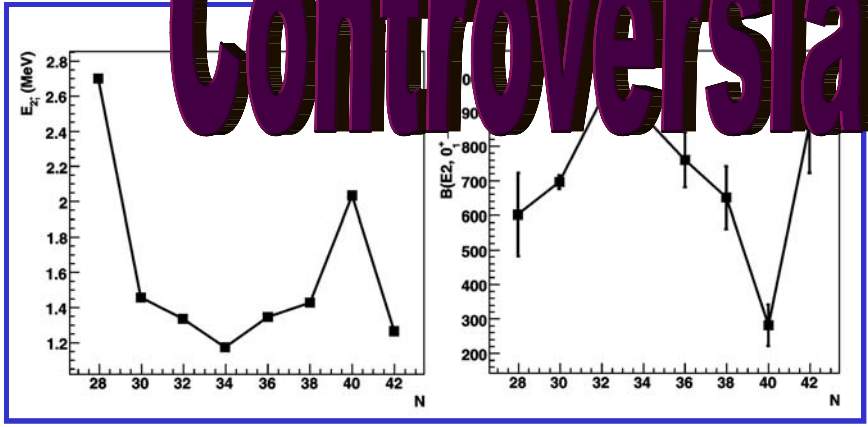
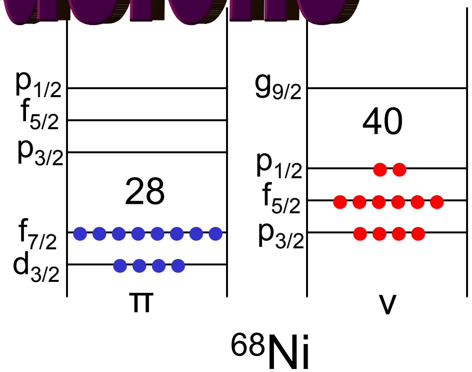
Controversial Conlcusions

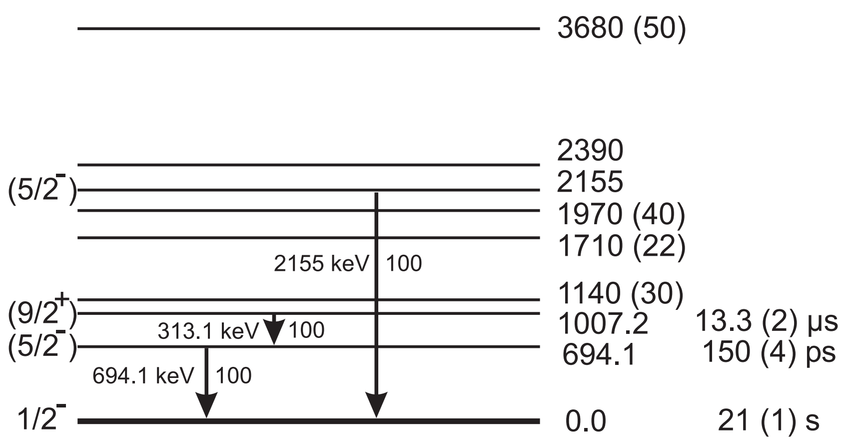


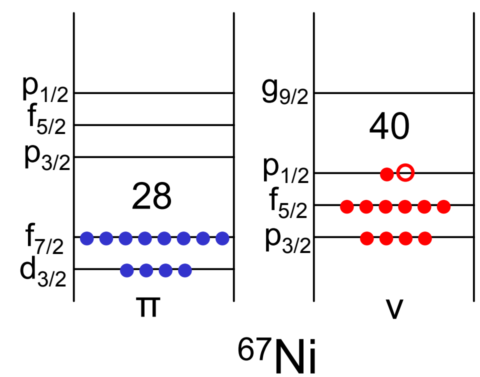


2. Introduction

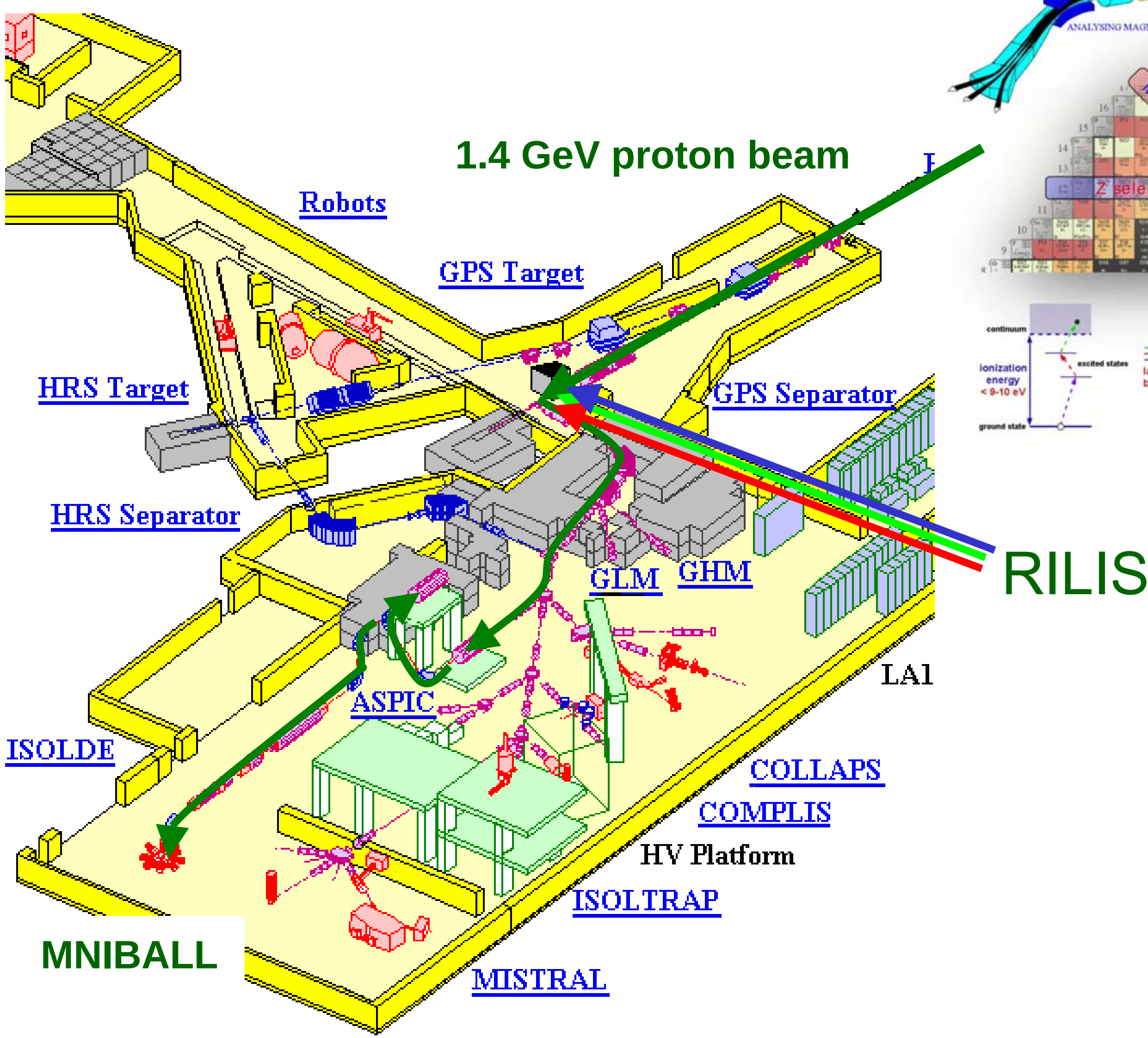
Study of the single particle character of the neutron rich Ni isotopes
Physics case: ^{2}H(^{66}NI,p)^{67}Ni [IS-469],Q = 3.583 MeV

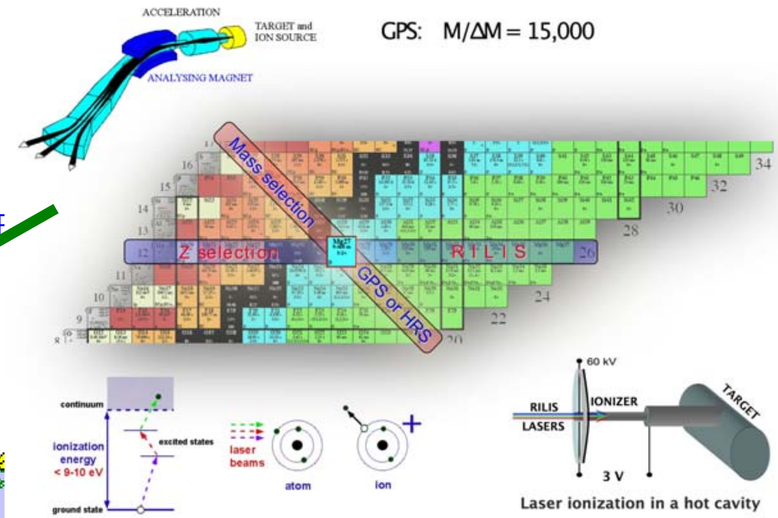
- ^{67}Ni^{g} one hole state of the ^{68}Ni
- g factor exp. value smaller by a factor of 2 than the expected for $1g_{9/2}$
- Unambiguous determination of the spin and parities of the the first excited states - one more state $\nu_{3/2}$ not yet observed
- Single particle character of the states of ^{67}Ni (relative SF's)
- A good starting point as to determine the single particle character of the Ni isotopic chain – single particle systematics

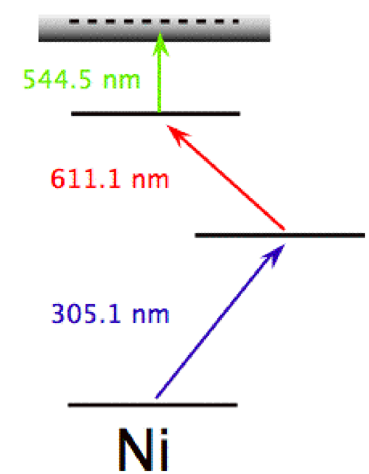




3. Experimental setup



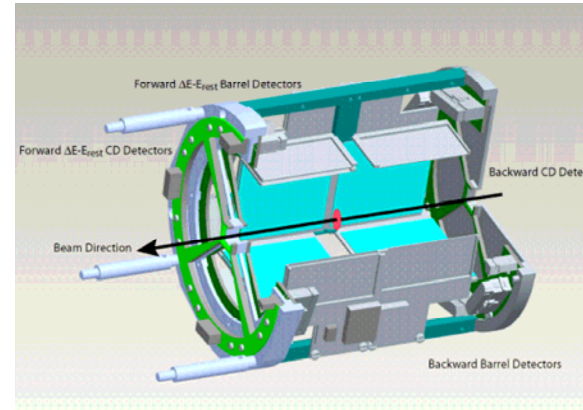




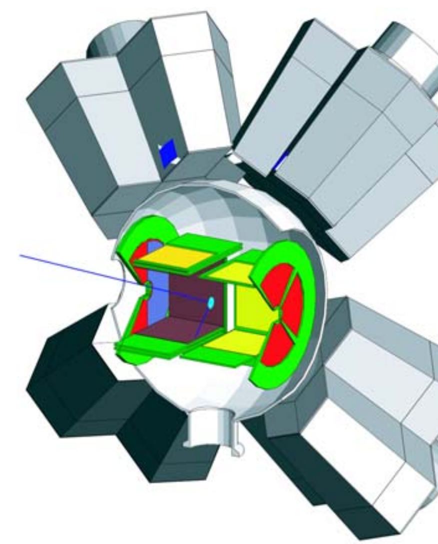
3. Experimental setup

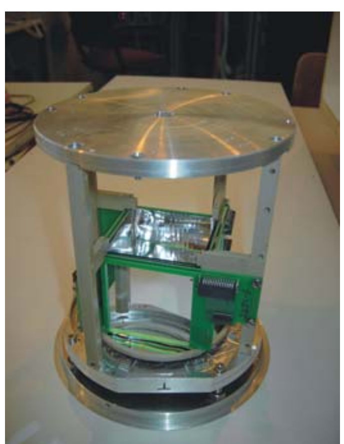
- Particle detection:

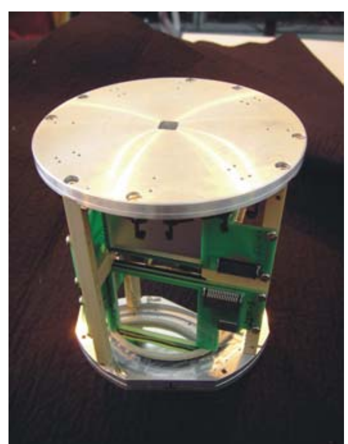
Detector	Angles	Thickness	Segmentation
Forw. CD (ΔE)	8-30	300 μm	16 annular x 24 radial
Forw. CD (E)	8-30	1.5 mm	no
Forw. Barrel (ΔE)	30-75	140 μm	16 stripes ⊥ beam + ch. Div resistive layer
Forw. Barrel (PAD)	30-75	1 mm	no
Back. Barrel	104-152	500 μm	16 stripes ⊥ beam + ch. Div resistive layer
Back. CD	152-172	500 μm	16 annular x 24 radial



- γ-ray detection: 8 Miniball clusters (ε ~ 8 %)
- Beam composition: Bragg detector, HPGe detector, Laser on/off



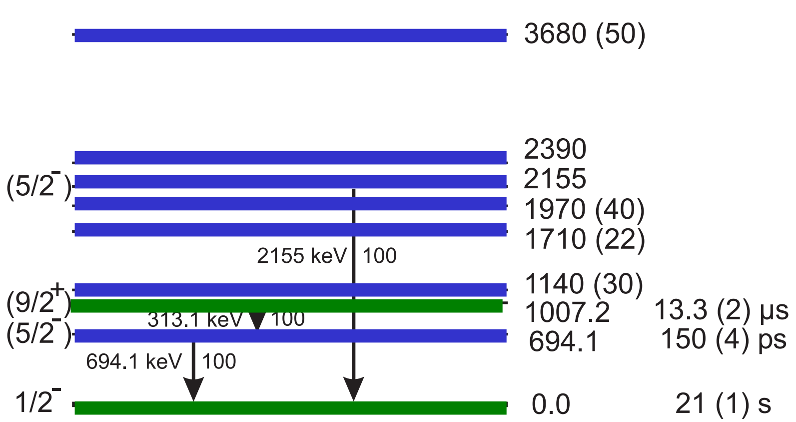


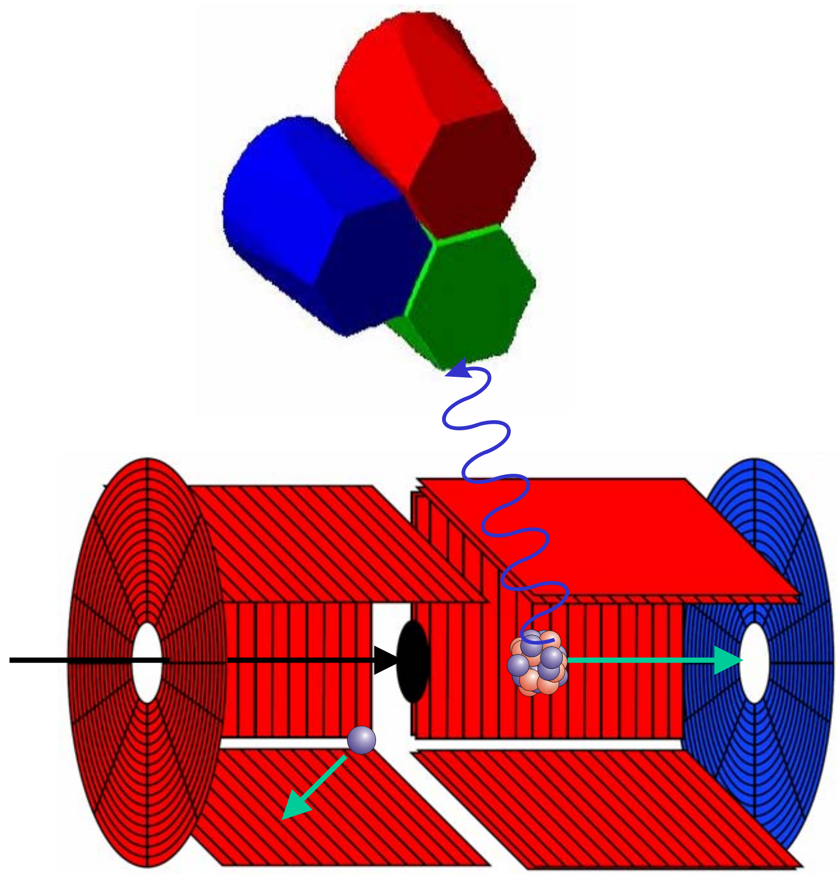


4. Technique

- "Thick" CD_2 target measurement (1mgr/cm^2)
  - Spectroscopic information for the excited states up to 3 MeV.
  - Coincidences with γ

- "Thin" CD_2 target measurement (100 μgr/cm^2)
  - Spectroscopic information for the ground and the second excited state.
  - Singles: only backward angles

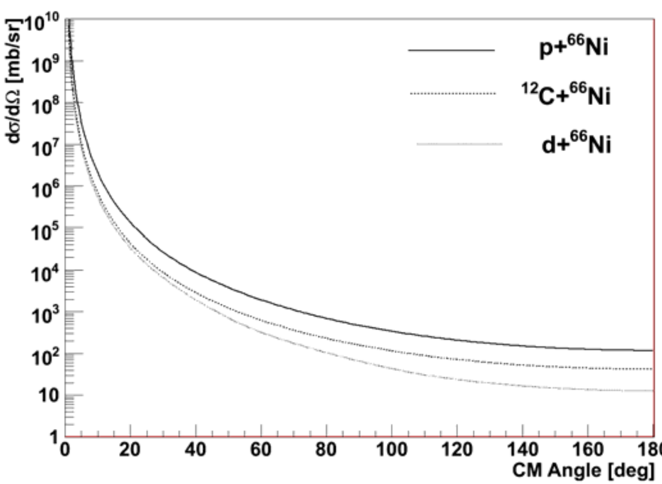




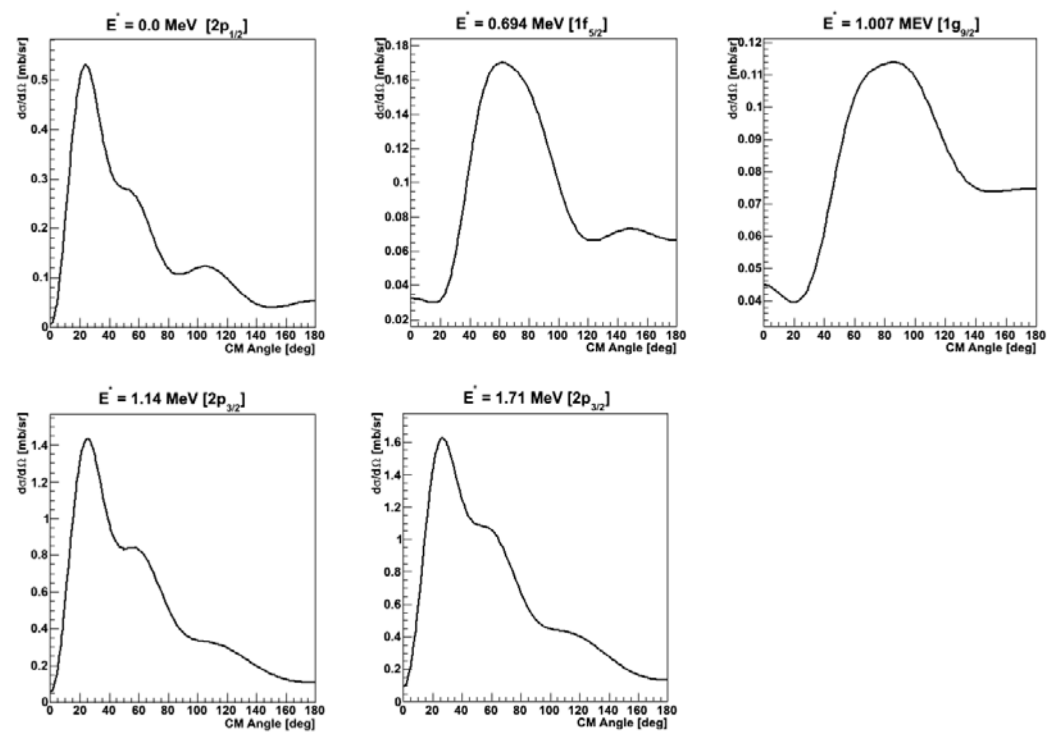
5. Simulations: Input & theoretical calculations

- DWBA (ground-1.7 MeV excitation energy)
- Elastic scattering with ^{12}C,^{2}H,H
- Detection geometry
- Target thickness
- Beam spatial profile
- Detector resolution
- …

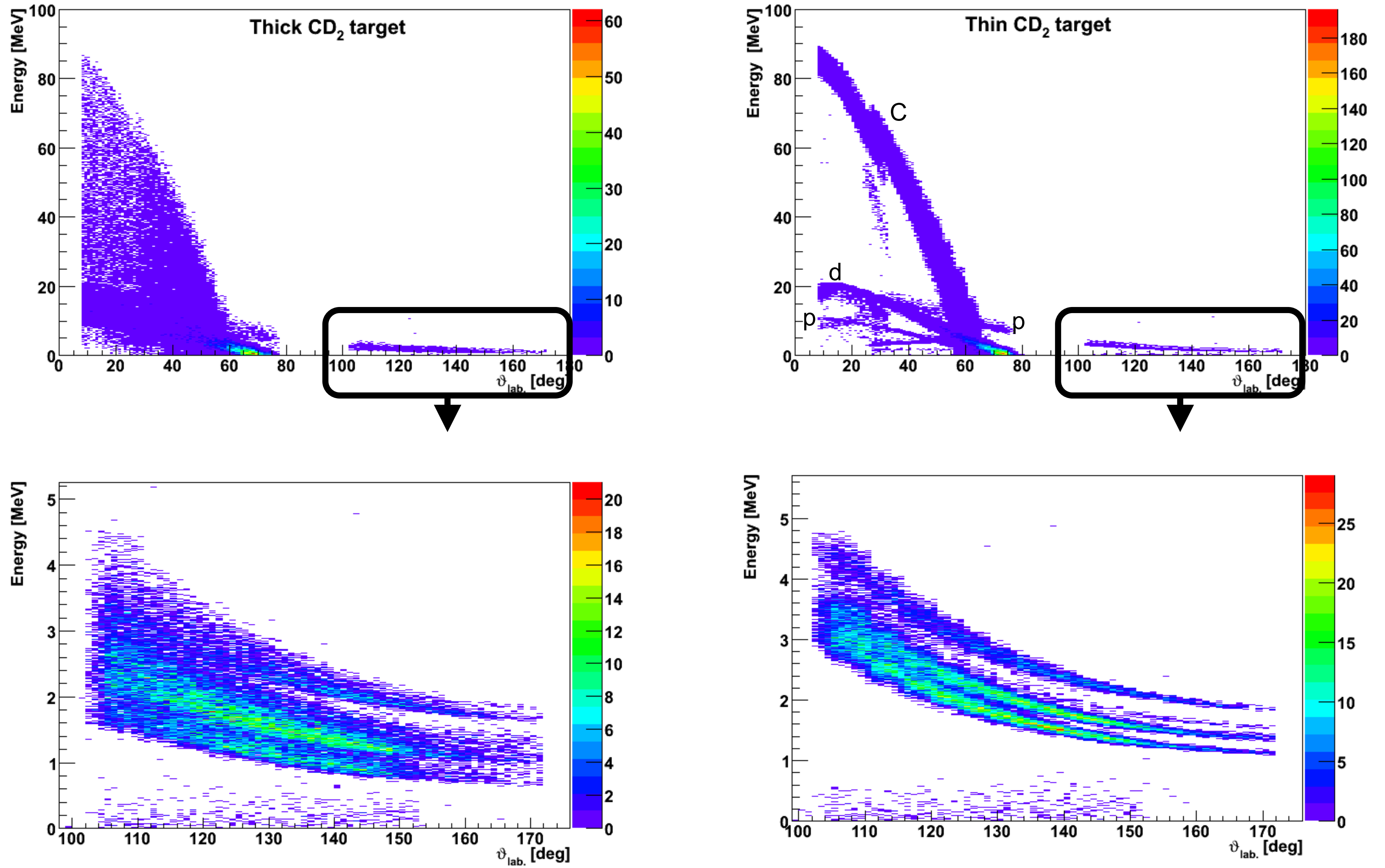
Elastic scattering



(d,p) Transfer Reactions: DWBA calculations



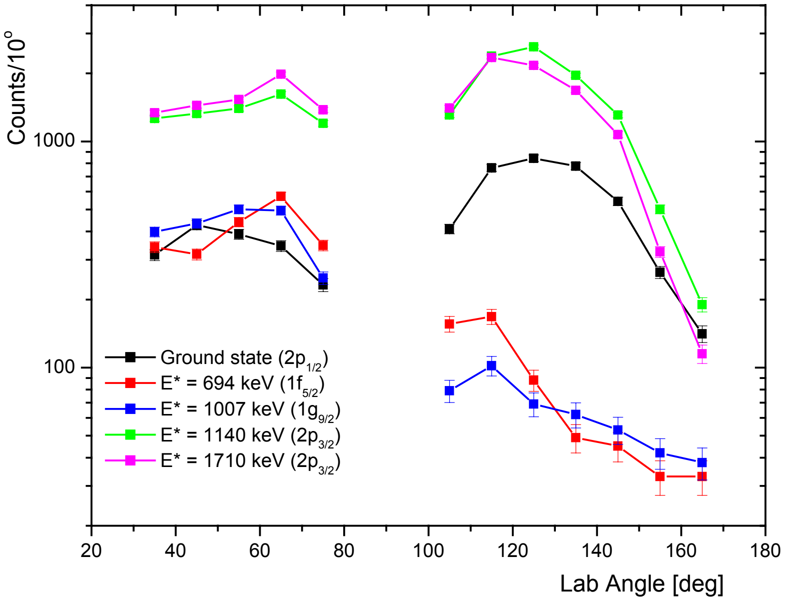
5. Simulations: Results



5. Simulations: Results & expected counting rate

Considerations:

- 10^6 pps at the MINIBALL target
  (ε_{REX} = 5%, Primary ISOLDE yield:1-3 10^7)
- ~ ε_{part} = 55 %, ε_{γ} = 8 %
- σ from DWBA assuming SF =0.2
- Beam time: **25 shifts in total**



Levels	Single particle state	Target (μgr/cm^2)	σ (mb)	events/h	Total number of events
ground	$2p_{1/2}$	1000	4.2	no p-γ coinc.	no p-γ coinc.
1	$1f_{5/2}$	1000	2.6	31	2700
2	$1g_{9/2}$	1000	2.2	no p-γ coinc.	no p-γ coinc.
3	$2p_{3/2}$	1000	13.4	160	14000
4	$2p_{3/2}$	1000	17	203	17800
ground	$2p_{1/2}$	100	4.2	62	5500
2	$1g_{9/2}$	100	2.2	32	2900
3	$2p_{3/2}$	100	13.4	200	17600

6. Conclusions

- The properties of the nuclei in the mass region around ^{68}Ni have been extensively studied up to now with controversial results
- The fragile nature of the N=40 subshell closure is not yet understood
- Next step-> study of the single particle properties starting with: d(^{66}Ni,p)^{67}Ni reaction
- Spectroscopic information can be obtained for the ground and first excited states of ^{67}Ni. Also the relative SF will be directly compared with shell model calculations
- Accepted proposal: Experiment IS-469

Collaboration

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Technische Universität Darmstadt, Germany

Ludwig-Maximillians-Universität München, Germany

INP, NCSR "Demokritos", Greece

Lund University, Sweden

CERN, Switzerland

University of Edinburgh, United Kingdom

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University of Manchester, United Kingdom

University of Paisley, United Kingdom

University of York, United Kingdom

THANK YOU